Remarks

1. Claims 1 and 4-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gharavi (5235420) in view of Fukuhara et. At (2001/0024530). However, the Applicant believes that Gharavi and Fukuhara are completely different inventions which relate to video coder while the Applicant invention relates to video quality measurement. Gharavi and Fukuhara take input video signals (source video sequences) and encode them, producing encoded video data. From the encoded video data, the decoder can decompress the data, producing video signals which may include some impairment due to encoding process. In particular, the impairments due to compression include blurring (loss of high frequency) and blocking (in low bit rate coding). Furthermore, if the compressed video data is transmitted over noisy channels, transmission errors might be introduced. These transmission errors may further degrade the video quality at the receiver. The impairments due to transmission errors include frame freezing, frame delay, jittering, error block, etc. The impaired videos due to either or both encoding or/and transmission errors are called "processed video sequences". On the other hand, the Applicant's invention takes a processed video sequence and the corresponding source video sequence, and predicts the video quality of the processed video sequence. In other words, the Applicant's invention produces a quality score for the processed video sequence using the information of the source video sequence.

Fig. 1 shows a block-diagram of a typical encoder. The encoder takes a source video, encodes it, and produces encoded video data. Fig. 2 shows an objective video quality measurement method, which takes two videos: a source (reference) video sequence and a processed video sequence. It compares the two video sequences and produces a number, which is a video quality score of the processed video sequence.

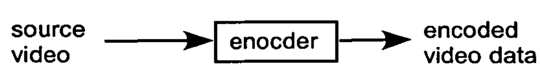

Fig. 1. A block-diagram of encoder (Gharavi, Fukuhara, Acharya).

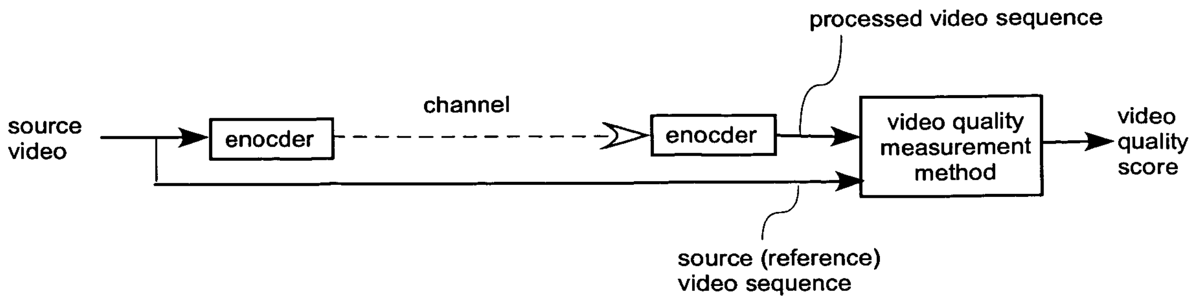

Fig. 2. A block-diagram of the video quality measurement method.

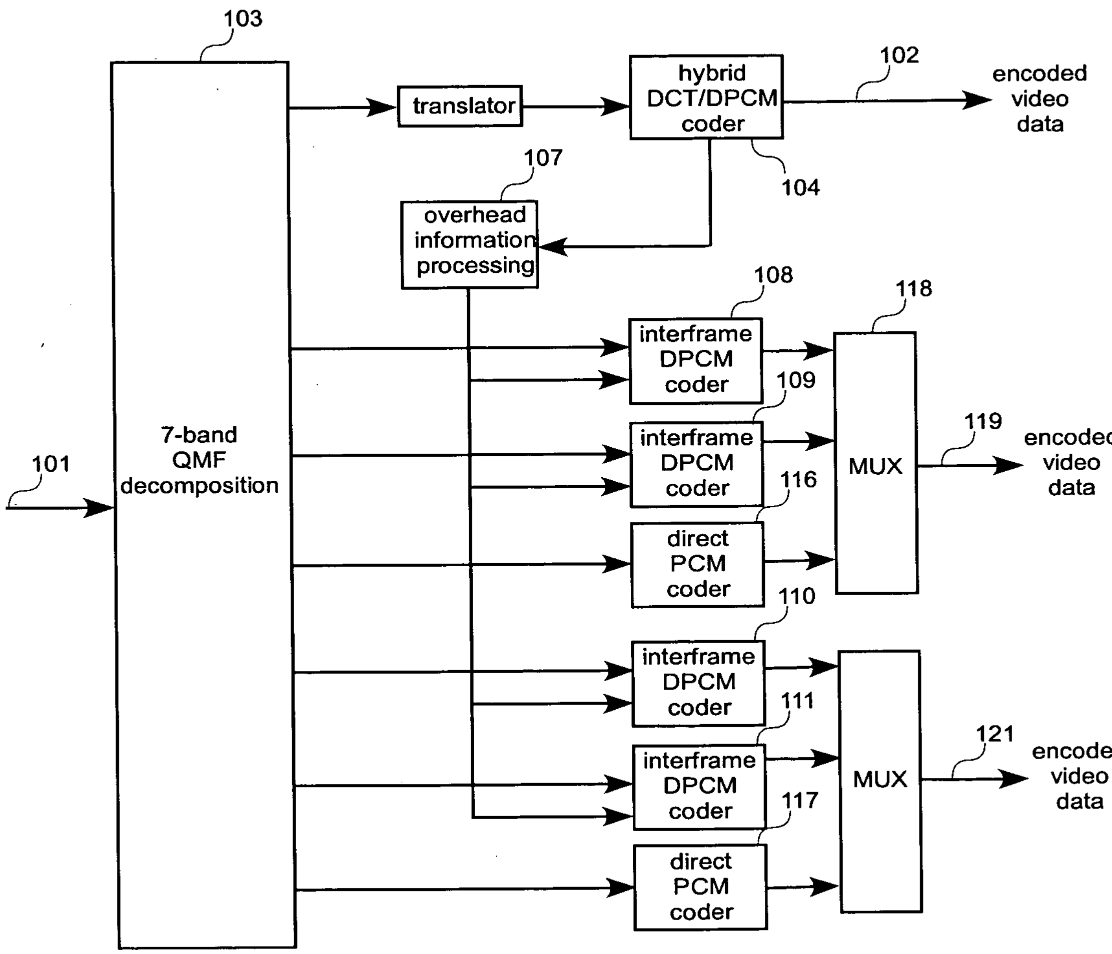

Fig. 3. A block diagram of the multilayer universal video coder of Gharavi.

Fig. 3 shows the representative diagram of Gharavi. The invention takes input HDTV signals 101 and applies the 7-band QMF decomposition to the signals. Then the decomposed signals are encoded using one of hybrid DCT/DPCM coder, interframe DPCM coder, and direct PCM coder. These encoded data are outputted. Some outputs of the coder are combined by MUX and included together in the same bit stream. The

overhead information processor 107 provides motion compensation predicting information and scene change information to the interframe DPCM coders 108-111. The function of the interframe DPCM coder (108-111) is to encode the decomposed sub-band signals using the information provided by the overhead information processor 107. Furthermore, the video coder of Gharavi also uses the hybrid/DCT/DPCM coder 104 and the direct PCM coder 116-117, which do not exist in the Applicant's invention. In fact, the Applicant's invention does not have any coder.

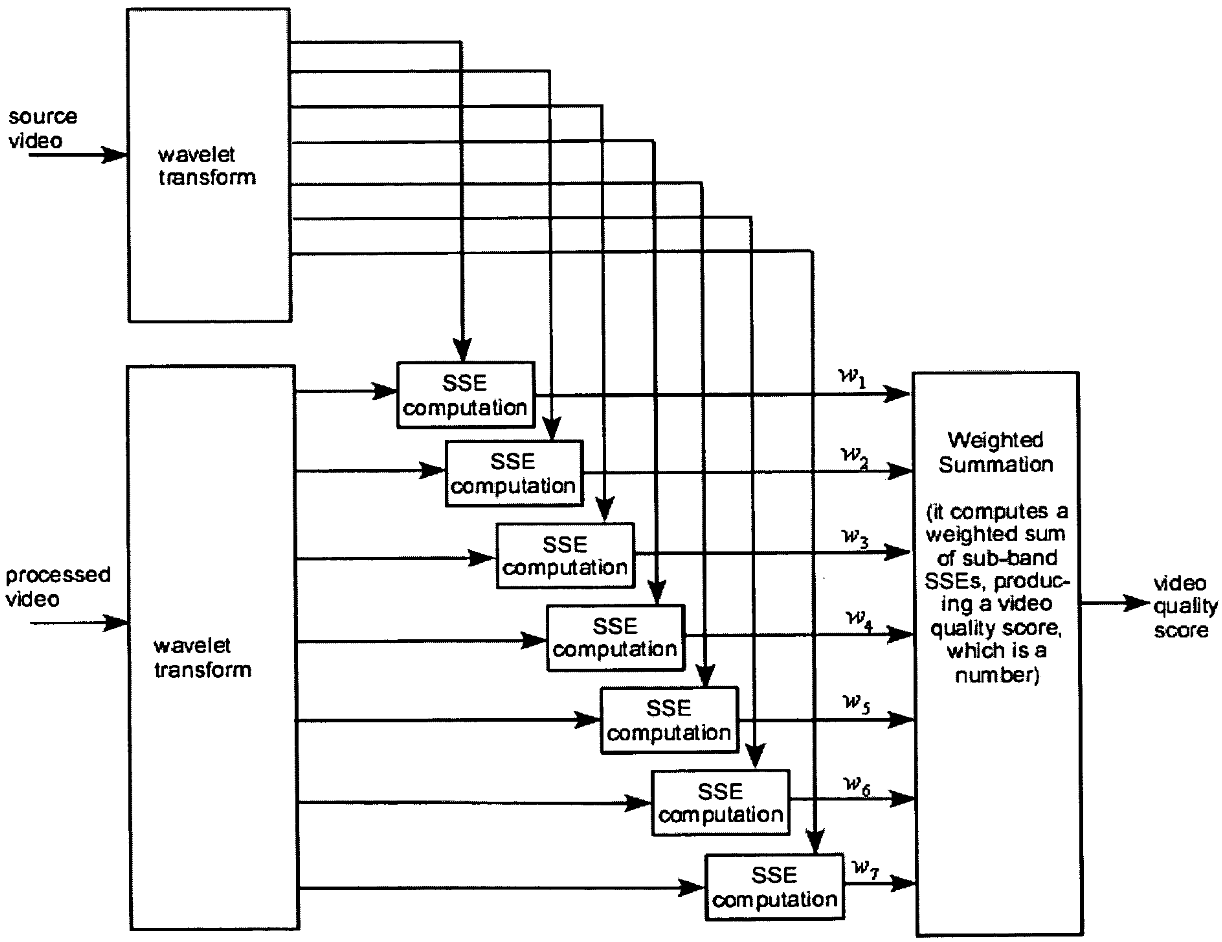

Fig. 4. A block diagram of the Applicant's method for video quality measurement.

Fig. 4 illustrates a representative diagram of the Applicant's invention. It applies wavelet transform to two input video signals. Then, the sum of squared errors (SSE) of each band for video sequences is computed. Finally, a weight is multiplied to each SSE and then a weighted sum of the SSEs of subbands is computed. This weighted sum, which is a number, is used as a video quality metric.

2. Items 108-111 of Gharavi are coders (DPCM, Differential Pulse Code Modulation) which encode subband signals of a source video and produce encoded data. On the other hand, the SSE computation unit takes two videos and produces a squared error.
3. The multiplexer in Gharavi combines encoded data and produces a single data stream while the weighted summation unit in the Applicant's unit computes a weighted sum of the SSEs of the subbands and produces an objective score. The Applicant noticed ambiguous wording in the original claims, which might cause confusion, and replaced them with new claims. In the new claims, it is clearly stated that an objective score is computed by taking an inner product of the final difference vector and a weight vector.
4. The invention of Fukuhara relates to a picture encoding method and apparatus. The paragraph 0013 of Fukuhara describes quantization steps which quantizes the wavelet transform coefficients using at least one of weighting coefficient of a table. This step of Fukuhara also produces encoded data. On the other hand, the Applicant's invention produces an objective score by taking an inner product of a final difference vector and a weight vector. The intended use and goal of weights are completely different.
5. The paragraphs 0123-0125 also describe encoding and decoding. In particular, the paragraphs describe scalability decoding, in which picture quality is gradually improved. On the other hand, the Applicant's invention computes spatial and temporal frequency differences between a source video sequence and a processed video sequence by applying a transform and produces a spatial and temporal frequency difference vector. Then, it produces an objective video score by taking the inner product of said spatial and temporal frequency difference vector and a weight vector.
6. Fukuhara uses the wavelet transform to encode video sequences while the applicant's invention uses the wavelet transform to compute an objective video quality score.
7. Claim 2 is rejected as being unpatentable over Gharavi in view of Fukuhara et at. in further view of Acharya et al. It is noted that Acharya's invention relates to image processing and encoding. Figures 4 and 6 of Acharya apply one-dimensional DWT (discrete wavelet transform) to each row of an image and then apply one-dimensional DWT to each column of the transformed image. Then the encoder encodes the final transformed image, producing encoded data. On the other hand, the Applicant's claim 2 (new claim 7) first applied a 2-dimensional wavelet transform to each frame of a

source video sequence and a processed video sequence and then computes a difference vector, whose element represents a subband difference, for each frame. This process is repeated for all the frames and a sequence of difference vectors is produced. Then, one-dimensional wavelet transform is applied in the temporal direction, producing a second sequence of difference vectors. The final difference vector is produced by averaging the second sequence of difference vectors. Finally, an objective video score is computed by taking the inner product of the final difference vector and a weight vector. The output of the Applicant's invention is a number (an objective video quality score) while the output of Acharya is encoded data of an image, from which the original image can be reconstructed with compression artifacts.